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Agonopterix sideensis from Turkey and *Exaeretia lvovskyi* from Russia, two new species of Depressariidae (Lepidoptera) from the Palaearctic region, and the transfer of *Exaeretia montuosella* (Hannemann, 1976) into the genus *Agonopterix* Hübner, [1825]

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Abstract: *Agonopterix sideensis* from Turkey and *Exaeretia lvovskyi* from Russia, two new species of Depressariidae (Lepidoptera) from the Palaearctic region, and the transfer of *Exaeretia montuosella* (Hannemann, 1976) into the genus *Agonopterix* Hübner, [1825]. *Misc. Pap*. 184: 1-25.

Agonopterix sideensis **sp. n.** and *Exaeretia lvovskyi* **sp. n.** are described and *Exaeretia montuosella* (Hannemann, 1976) is transferred to the genus *Agonopterix* Hübner, [1825]. *Agonopterix sideensis* had been reared from larvae, collected in Side, Antalya Province, South Turkey, from an undetermined plant, and so far it is only known from the type locality. Externally it is most similar to *Agonopterix leucadensis* (Rebel, 1932), but the male genitalia show a quite unusual feature for this genus, a protruding tooth in the middle of the lower edge of the valva. This may suggest that the cuiller is bifurcate, as is typical of *Exaeretia*, but here this structure is a process of the lower edge of valva and not part of the cuiller. Further features, especially the shape of the labial palpus, female genitalia and the DNA-barcode leave no doubt that *A. sideensis* is well nested in the genus *Agonopterix*. Comparsion of *A. sideensis* with further *Agonopterix*- and *Exaeretia*-species brought to light one example in which this unusual structure is also present: "*Exaeretia" montuosella*. Studies of details of the valva, labial palpus and DNA-barcode revealed that it is not an *Exaeretia*. Taxonomic consequences: *Exaeretia montuosella*, described as *Depressariodes montuosellus* Hannemann, 1976, is transferred to *Agonopterix montuosella* (Hannemann, 1976), **comb. nov**.
Exaeretia lvovskyi is close to the species *E. lepidella* (Christoph, 1872), *E. nebulosella* (Caradja, 1920), *E. buvati* Nel & Grange, 2014, *E. mongolicella* (Christoph, 1882), *E. amurella* Lvovsky, 1990 and *E. praeustella* (Rebel, 1917), but somewhat isolated within this group. It is found in Russia (South Ural, Altai Mountains, Buryatia). The moth and the genitalia of the new species and six of its related species are illustrated.

Keywords: Lepidoptera, Depressariidae, *Agonopterix*, *Exaeretia*, Russia, Turkey, new species, intraspecific variability, DNA barcoding, NGS-sequencing.

Introductory remarks

During a collecting trip of JJ and KN in South Turkey in April 1995, light trapping became impossible due to bad weather conditions. Therefore the focus was put on collecting larvae, resulting in an unusually high number of reared moths. But for more than 20 years it had not been realized that among these there is an undescribed species hidden. Dissection of one male, believed to be *Agonopterix leucadensis* (Rebel, 1932), showed one very unusual feature usually not found in

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this genus. Further studies of the external appearance, female genitalia and DNA-data confirmed the placement in *Agonopterix* and opened the way to describe it as *Agonopterix sideensis*.

Among material collected in 1996 in Russia, South Ural, the authors found a somewhat worn specimen of an *Exaeretia,* very similar externally and in the male genitalia to *E. nebulosella* (CARADJA, 1920), but it was also similar to other species, e.g. *E. lepidella* (CHRISTOPH, 1872), *E. buvati* NEL & GRANGE, 2014, *E. mongolicella* (CHRISTOPH, 1882) and *E. amurella* LVOVSKY, 1990. Subsequently, more specimens were found in the Altai Mountains and Buryatia, among them fresh ones. From comparison with the type series of *E. nebulosella* in MGAB (Bucharest) and material in ZIN (St. Petersburg) it was soon clear that this species was different from *E. nebulosella* and also from other *Exaeretia* species. As no female had been collected, and with the male genitalia being very uniform in this group, the description was postponed until further notice, in the hope of finding females. In 2015, Jan Šumpich was able to collect a long series of this sp.n. in the Altai Mountains, including a single female, which allows the description of this species as *Exaeretia lvovskyi*. Genitalia of both sexes and DNA barcode data show that it is in fact close to the mentioned species group, but nevertheless somewhat isolated within the group.

Methods

Morphological examination: all genitalia preparations were made by P. Buchner and all photographs were taken by him, if not otherwise specified. The preparations follow standard techniques (Robinson, 1976). Male preparations were stained with mercurochrome and females with chlorazol black E, which brings a better result than using the same stain for both sexes.
Photographic documentation: photographs of set specimens were taken with Canon EOS 5D Mark III and Canon lens EF 100mm 2.8 L IS USM at 1:1. Photographs of unset specimens and specimen details were taken with Canon lens MP-E 65 at 2:1, using ring flash. Genitalia photographs were taken through a microscope (Wild Heerbrugg) using a 10x objective and a 2.5x ocular. All photographs were edited using the software Helicon Focus 4.80 and Adobe Photoshop 6.0.

Abbreviations

DEEUR "Depressariinae of Europe", prefix for specimen-number of Depressariinae studied by P.Buchner
HNHM Hungarian Natural History Museum, Budapest
MFN Museum für Naturkunde, Berlin, Germany
MFSN Museo Friulano di Storia Naturale, Udine, Italy
MNHN Muséum National d'Histoire Naturelle, Paris, France
MGAB "Grigore Antipa" National Museum of Natural History, Bucharest, Romania
NHMV Natural History Museum Vienna, Austria
NMPC Národní Muzeum Prague, Czech Republic
RCJJ Research Collection Jari Junnilainen, Vantaa, Finland
RCKN Research Collection Kari and Timo Nupponen, Espoo, Finland
SMNK Staatliches Museum für Naturkunde Karlsruhe, Germany
TLMF Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria
ZIN Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia
ZMUC Zoological Museum, University of Copenhagen, Denmark
ZSM Zoologische Staatssammlung München, Germany

Agonopterix sideensis sp. n.

http://zoobank.org/NomenclaturalActs/07AB563A-A28F-409A-BF35-51010E2D0854

Description

Adult (figs 1 - 5): wingspan 21-23 mm. Scales of head light yellowish buff, becoming darker towards vertex. Labial palpus: second segment 1 - 1.2 mm long and up to 0.6 mm wide in lateral view, pale yellowish nearly throughout in male, mixed with darker scales in female, third segment 1 - 1.2 mm long, slender, pale yellowish with small blackish markings at base and tip and a large blackish area in the middle, on inner side up to 0.5 mm long (figs 4 - 5). Antenna mid-brown, narrow, no difference in diameter between female and male. Thorax with posterior crest, tegulae and posterior half of thorax yellowish buff, anterior half darker yellow to brown. Forewings: moderately narrow (width about 1/3 of length), termen broadly rounded, ground colour yellowish buff with mid to dark brown elements, which form a basic pattern common in *Agonopterix*: two small oblique dark dots at 1/3, and a third dot at half-way to dorsum, a larger dark dot at ½,

accompanied proximally by a few scales paler than yellowish ground colour, but not white, between inner group of dots and central dot a diffuse blackish spot a little closer to costa than central dot; additionally to these constant elements there is a dark area distad of the pale basal field, a spot at dorsum at about 2/3 and a diffuse transverse band at 4/5, irregularly groups of darker scales scattered throughout surface in individually variable proportion; Along costa from 1/10 to 4/5 there are 6 rather distinct dark spots, followed by 2 indistinct dots toward apex, dots between veins indistinct. Cilia not contrasting with ground colour, slightly darker subterminally, but this area not forming a distinct dark line (figs 1 - 2). Underside of forewing mid-grey, at the edges becoming yellowish grey with yellowish area broadest at costa, cilia similar to ground colour (fig. 3). Hindwings greyish, becoming paler and slightly translucent toward base, base of cilia yellowish grey, rest of cilia similar to ground colour, underside of hindwings similar to upper surface, but with a few distinct dots between veins. Legs: with predominantly pale yellowish scales, but more dark scales in forelegs (figs 1 - 3).
Variation: within the three specimens of the type series, the two males are markedly paler than the female. Further findings are needed to discover if this difference is a sexual character. In general, sexual dimorphism is not found in the genus *Agonopterix*, which makes it likely that this difference is based on intraspecific variability.

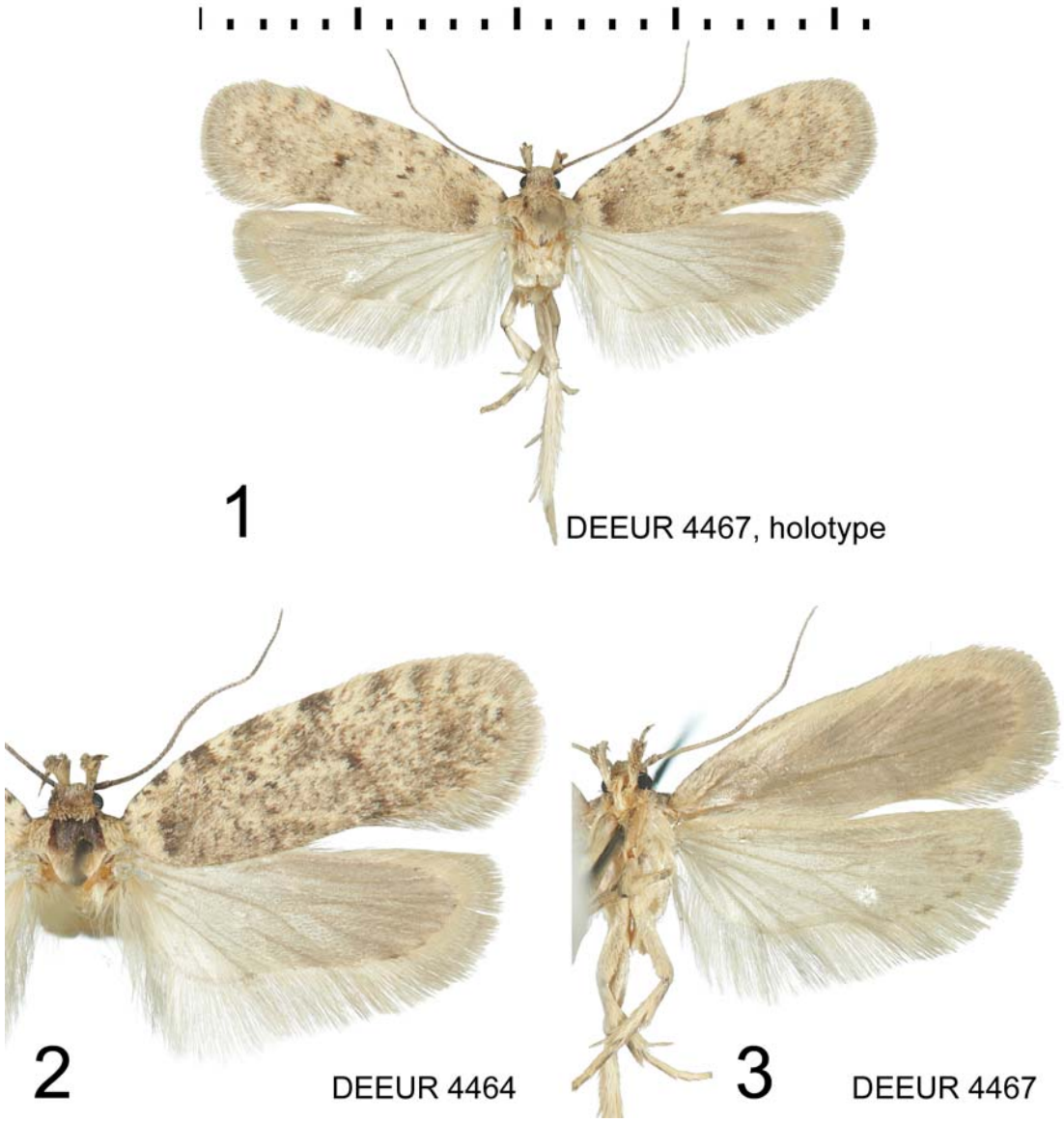


FIGURE 1: *A. sideensis*, holotype, general view
FIGURE 2: *A. sideensis*, ♀ paratype, general view
FIGURE 3: *A. sideensis*, holotype, underside

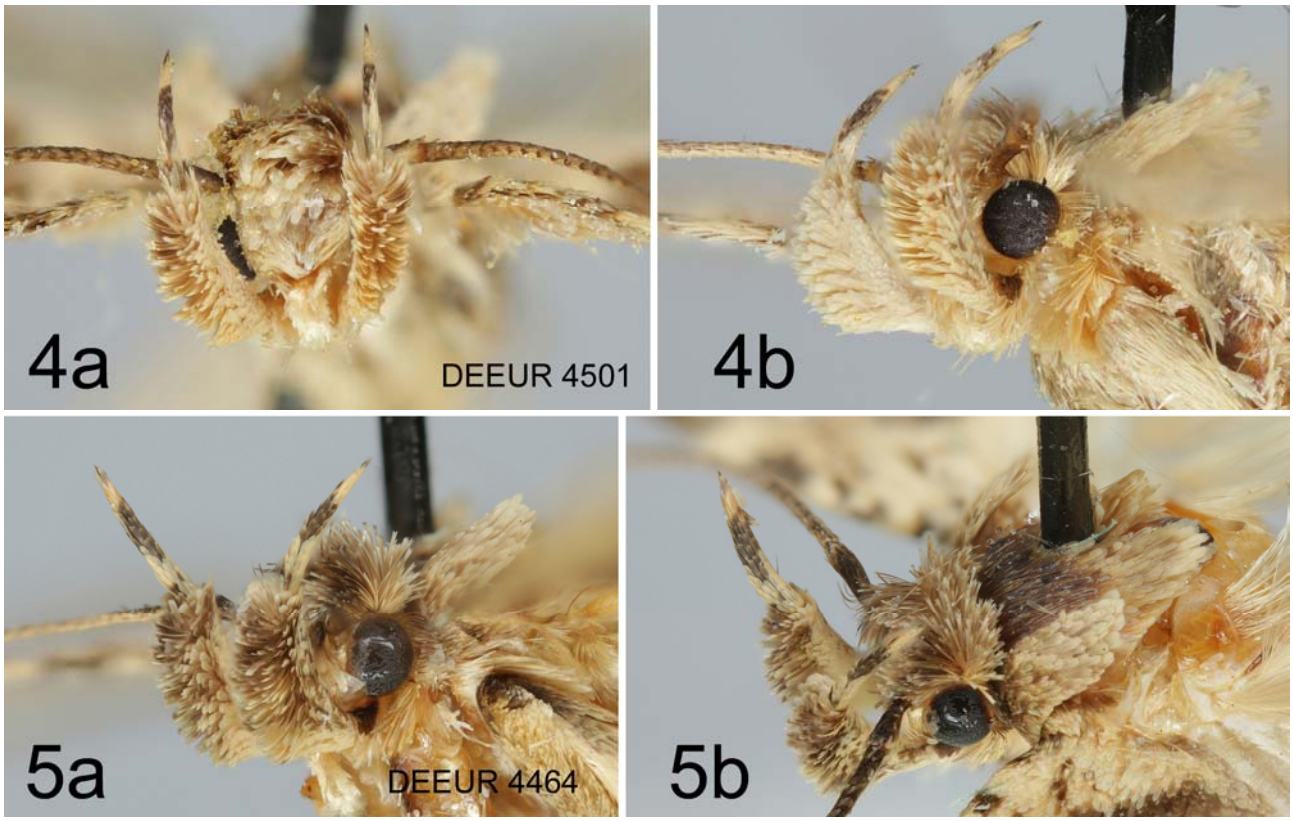


FIGURE 4: *A. sideensis*, ♂ paratype, head and labial palpus
FIGURE 5: *A. sideensis*, ♀ paratype, head and labial palpus

Male genitalia (fig. 6, all measures refer to standard preparation)

Socii large, each elliptic with diameter of 0.5 mm transversally and 0.8 mm longitudinally, uncus triangular, distinct, slightly exceeding gnathos, which is broadly elliptic and rather small with 0.3 mm diameter and 0.4 mm length. Transtilla narrow, slightly widened medially, transtilla lobes semicircular, transverse diameter 0.3 mm, gap between them 0.2 mm; anellus rather small, longitudinal expansion 0.6 mm, gap to transtilla 0.3 mm, with deep V-shaped incision which is filled with a thin and translucent membrane, anellus lobes with remarkable large circular appendages, each covering nearly whole of the half of anellus; valva with a structure at lower edge usually not found in *Agonopterix*: at 2/5 from base, the edge bends outwards by about 25 degrees and at 3/5 it forms a triangular projection protruding about 0.1 mm beyond edge of valva; cuiller stout, reaching costa of valva or nearly so, with some shallow grooves apically. Phallus slightly bent (20 degrees) in lateral view, with a distinct bulge medially on ventral side at about 3/5, strongly asymmetric in ventral view with a tooth extending to the right side in the area of the bulge, basal process long and about as wide as phallus, reaching its middle and terminating in a shallow excavation.

Remarks: at first sight, the protruding projection at lower edge of valva might be thought to be the lower branch of a bifurcate cuiller, a feature characteristic of *Exaeretia*. A closer look reveals that this structure is entirely a formation of the lower edge of the valva, while the cuiller is undivided, as is characteristic of *Agonopterix* (figs 17 – 19). This generic placement is confirmed by other features, e.g. shape of labial palpus (figs 20 - 23), female genitalia and barcode.

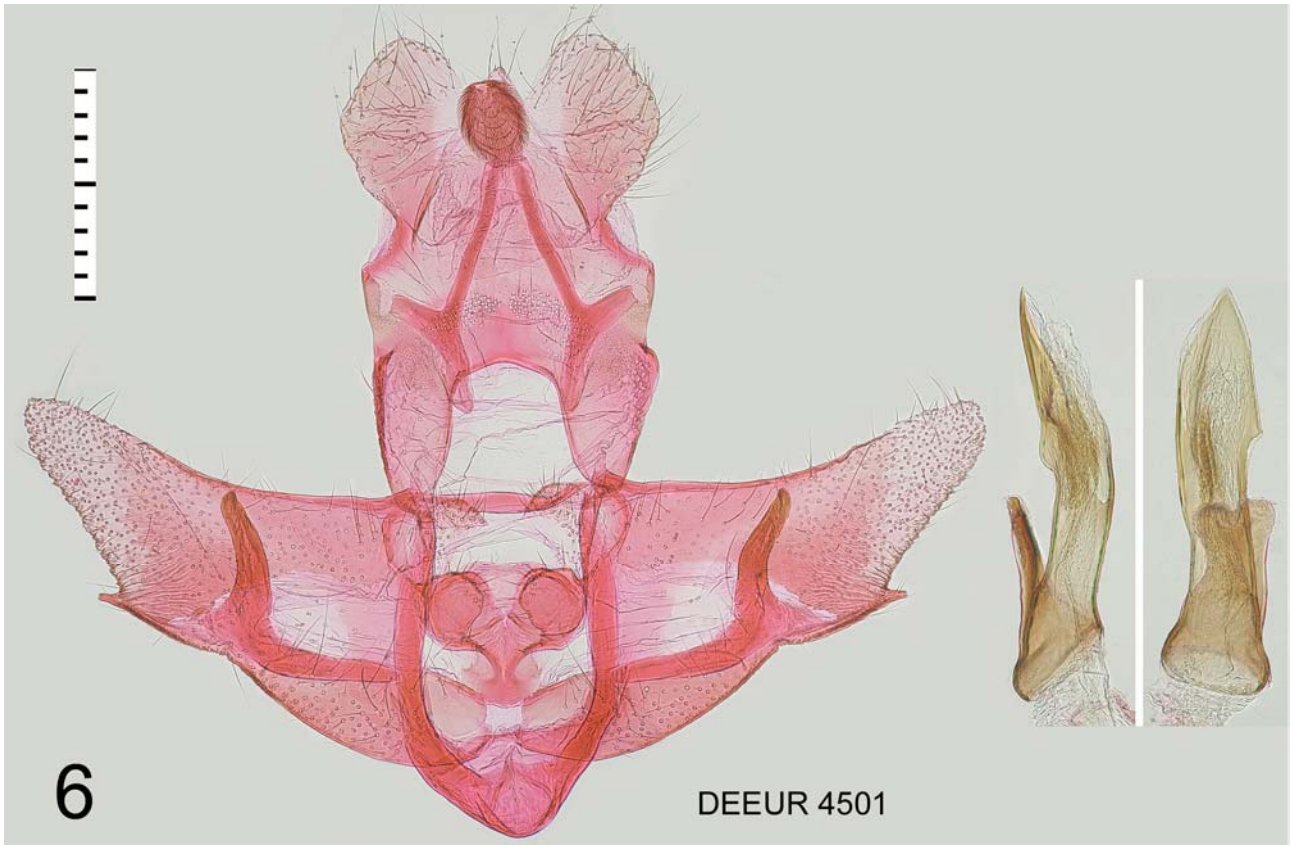


FIGURE 6: *A. sideensis*, ♂ paratype, phallus shown in lateral and ventral view; scale bar: 1 line = 0.1 mm in the slide

Female genitalia (fig. 7)

Papillae anales about 1.0 mm long, apophyses posteriores 1.4 mm; sternite VIII 1.1 mm long, maximum width 2.2 mm in standard preparation, apophyses anteriores 0.7 mm; proximal edge of sternite VIII slightly concave in centre, 0.1 mm from the centre starts a fold of 0.2 mm length on either side (fig. 7a, also as an enlarged insert), ostium about 0.2 mm long and 0.3 mm wide, located just caudad of middle of sternite VIII, continuing to caudal edge in a V-shaped structure (fig. 7b), on either side of it and the ostium an area of fine folds (fig. 7c, also as an enlarged insert), antrum 0.3 mm long and constricting to about 0.15 mm diameter, at the origin of ductus spermathecae ductus bursae is 0.3 mm in diameter, remaining at this width for 2.5 mm, then gradually widening into the pyriform bursa copulatrix, total length of this section about 4 mm, width in standard preparation 2.5 mm; signum slightly distad from centre, elongate-oval, 0.4 mm long and 0.9 mm wide, the longitudinal axis without teeth, on either side of this area about 15 small triangular teeth pointing laterally; ductus spermathecae with about 5 turns.

FIGURE 7: *A. sideensis*, ♀ paratype, scale bar: 1 line = 0.1 mm in the slide, for inserts see "Diagnosis"
FIGURE 8: *A. leucadensis,* Greece, Peloponnes, Leonidio, 18.v.2009, leg. & coll. T. Mayr
FIGURE 9: *A. pallorella*, Turkey, Tuz Gölü, 20.vii.1970, leg. Friedel, coll. SMNK

Diagnosis

Wing pattern of *A. sideensis* is similar to those of several species, especially *Agonopterix leucadensis* (Rebel, 1932) (fig. 10), which was the initial determination of this new species and from which it is not readily discernible externally.

Male genitalia are very distinct and almost unmistakable due to the projection on the lower edge of valva, absent in *A. leucadensis* (fig. 11). This character is shared with just one other species: *Exaeretia montuosella* (described as *Depressariodes montuosellus* Hannemann, 1976), which is misplaced in *Exaeretia* and must be transferred to *Agonopterix*. Externally it differs from *A. sideensis* by its smaller size with a wingspan of 17-18 mm and narrower forewings (figs 12 - 13), male genitalia with very narrow anellus lobes, cuiller not much longer than half width of valva, phallus in ventral view only slightly asymmetric with basal process only 1/3 of phallus length (figs 14 - 15, 18).

Female genitalia of *A. sideensis* show no unusual features for the genus *Agonopterix*. Diagnostic features for this species are areas with fine folds on either side of the ostium (fig. 7c), a shallow excavation of sternite VIII on its proximal edge with one distinct fold on either side of its centre nearly parallel to proximal edge (fig. 7a), antrum rather long and slightly funnel-shaped, tapering to a diameter of ½ of ostium diameter, distal half of ductus bursae with a diameter similar to ostium. In *A. leucadensis* (fig. 8) the area of fine folds lateral from ostium and the pair of distinct folds near proximal edge of sternite VIII are absent, antrum is very short and therefore ductus spermathecae arises very close to the ostium and ductus bursae is clearly wider than the diameter of ostium throughout its length. *A. pallorella* is depicted (fig. 9) as an example from the species-group which is closest in barcode and which is mentioned in detail in the NJ-tree (fig. 24). It represents a very common example of female *Agonopterix*-genitalia, but is sufficiently different from *A. sideensis* for a safe determination. Females of *Agonopterix montuosella* are unknown.

Remarks on a possible determination problem: determination of *Agonopterix sideensis* should be reliable if based on the male genitalia, but not in those of the female. This is because none of the female genitalia in the large genus *Agonopterix* are very different. Almost no species of this genus can be characterized by a single feature in the female genitalia, only by a combination of several features, if at all. To make matters worse, intraspecific variability and also variations due to preparation artefacts create differences that may be greater than the diagnostically important interspecific differences. In *Agonopterix sideensis* a further detail must be kept in mind: so far only one female has been collected, so the extent of intraspecific variability is unknown. Thanks to barcoding, however, another method has recently become available offering the chance to come to a safe determination in cases of doubt.

Remarks on the generic placement of *Agonopterix montuosella*: a closer look at its cuiller (fig. 18) shows that it arises from the basal sclerotization as usual in *Agonopterix*, but no sclerotized connection to the projection on the lower edge of the valva exists (figs 16, 17), while in *Exaeretia* both parts are connected by a sclerotized line (fig. 19). This systematic position is confirmed by the shape of the second segment of the labial palpus: in *Exaeretia*, it is rather long, covered with densly appressed scales and therefore narrow, and the third segment is comparatively short (as an example fig. 23). In *Agonopterix*, such palpus can be found in a few species, but usually the scales of the second segment project forward and the third segment is rather long and narrow (figs 20 - 22), a feature not found in *Exaeretia* (Buchner, 2015). Barcode data also confirm the placement in *Agonopterix*, for details see under “Related species”

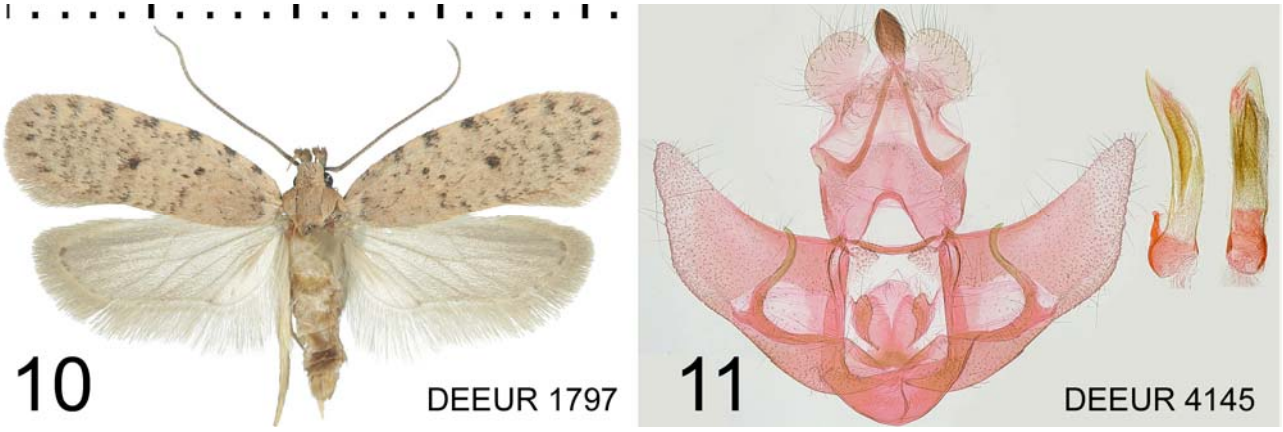


FIGURE 10: *A. leucadensis,* data as in fig. 8
FIGURE 11: *A. leucadensis,* male genitalia, Greece, Spile, 17.x.2012, leg. & coll. Cs. Szabóky

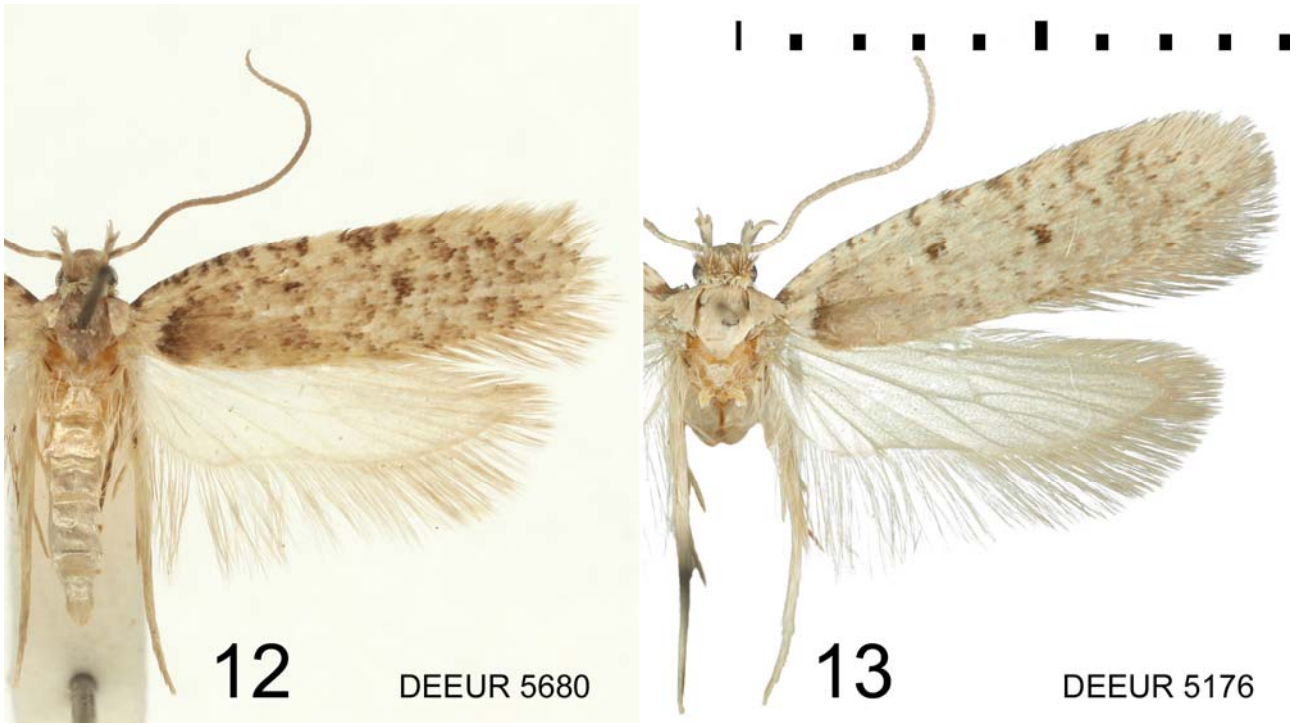


FIGURE 12: *A. montuosella*, paratype, general view; Afghanistan, Paghman 30 km NW Kabul, 2200 m, 20.-22.vii. 1963, leg. Kasy & Vartian, coll. MFN
FIGURE 13: *A. montuosella*, paratype, general view; Afghanistan, Paghman 30 km NW Kabul, 2200 m, 29.vi.-8.vii.1963, leg. Kasy & Vartian, coll. NHMV

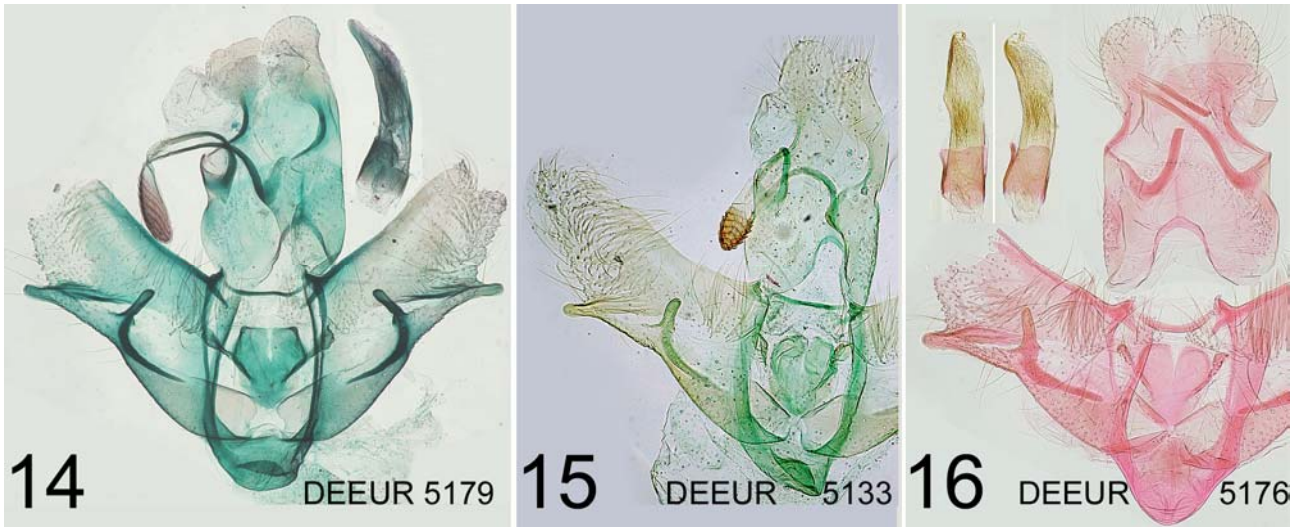


FIGURE 14: *A. montuosella*, holotype, Afghanistan, Paghman 30 km NW Kabul, 2200 m, 20.-22.vii.1963, leg. Kasy & Vartian, coll. NHMV, preparation H.J. Hannemann with I.N. 4426, NHMV storage number 5103
FIGURE 15: *A. montuosella*, paratype, Afghanistan, 40 km SW Kabul, 2300 m, 29.vi.1965, leg. Kasy & Vartian, coll. NHMV, preparation H.J. Hannemann with I.N. 4409, NHMV storage number 5104
FIGURE 16: *A. montuosella*, paratype; Afghanistan, Paghman 30 km NW Kabul, 2200 m, 29.vi.-8.vii.1963, leg. Kasy & Vartian, coll. NHMV, NHMV storage number 19881
Remarks: some of the specimens of the type series stored in NHMV showed damage to the abdomen

FIGURE 17: *A. assimilella*, cuiller; Italy, Toscana, Marradi, 4.viii.1999, leg. A. Usvelli, coll. MFSN
FIGURE 18: *A. montuosella*, holotype
FIGURE 19: *E. lvovskyi*, paratype, for data see paragraph "Material" in its description in this paper

FIGURE 20: *A. montuosella*, paratype
FIGURE 21: *A. carduncelli*, paratype; Portugal, Algarve, Boliquieme, 20.xi.2010, leg. M.J. Dale, coll. M. Corley
FIGURE 22: *A. kaekeritziana,* Austria, Gramatneusiedel, e.l. *Centaurea scabiosa*, e.p. 15.vi.1960, leg. & cult. F. Kasy, coll. NHMV
FIGURE 23: *Exaeretia allisella,* Switzerland, Ardez, e.l. *Artemisia vulgaris*, e.p. 14.vi.2009, leg., cult. & coll. P. Sonderegger.

Material

Holotype : ♂, Turkey, Antalya, Side, E 31°24' N 36°47', 10 m, larva from undetermined plant iv.1995, ex pupa 11.v.1995, leg. & cult. J. Junnilainen & K. Nupponen, DNA barcode id. TLMF Lep 19226, DEEUR 4467, will be deposited in coll. RCKN

Paratypes: 1 ♂, 1 ♀, same collecting data as holotype, ex pupa 11.v.1995, DNA barcode id. TLMF Lep 19235, DEEUR 4501, coll. RCJJ (♂),ex pupa 6.v.1995, DNA barcode id. TLMF Lep 19284, DEEUR 4464, coll. RCKN (♀)

Genetic data

Barcodes under

TLMF Lep 19226 (658 bp., ♂, holotype)
TLMF Lep 19235 (307 bp., ♂ paratype)
TLMF Lep 19284 (237 bp., ♀ paratype)

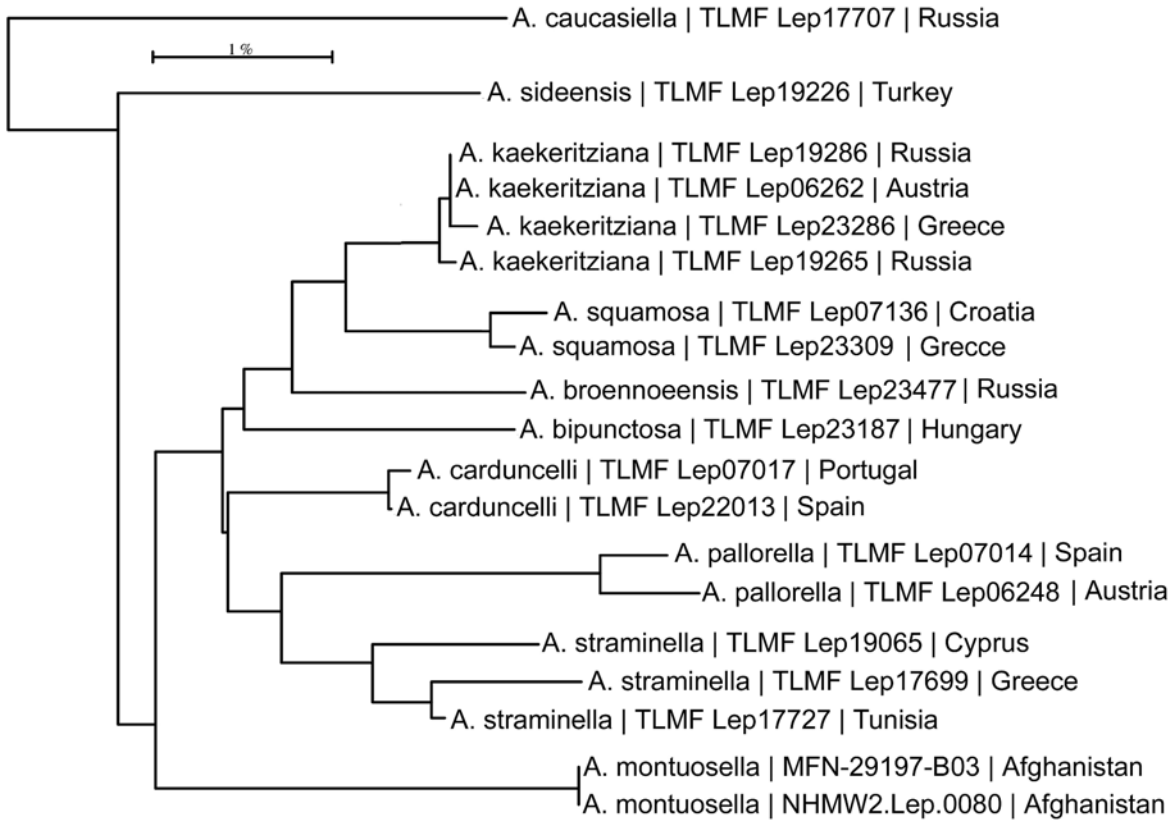


FIGURE 24: neighbour-joining tree of *Agonopterix sideensis, A. montuosella*, a selected species- group with comparatively close sequences and *A. caucasiella* as an example of an outgroup.
The main reason for this NJ tree is to show that *Agonopterix sideensis* and *A. montuosella* are not close species and no really close species could be found for either in the rest of the genus *Agonopterix*, nevertheless they are well nested in this genus.

The sequences can be found in the dataset DS-DEEUR355, which is accessible via this doi: dx.doi.org/10.5883/DS-DEEUR355, for details see the table in Appendix

Biology

Larvae have been collected from an undetermined herbaceous plant in mid-April, the first moth emerged on 6. v. and two more on 11. v., which makes it likely that the species does not hibernate as an adult, but due to the low altitude and the Mediterranean climate where the larvae were collected this cannot be excluded.

Etymology

The species name is derived from Side (Antalya Province, South Turkey) the area where the type series was collected.

Distribution

So far known only from Turkey.

Related species

The male genitalia of *A. sideensis* share a most remarkable feature, the projection of the lower edge of valva, with *A. montuosella*. Therefore it was expected that these two species would be closely related and that they would be more distant from all other *Agonopterix* spp. But surprisingly, barcode results contradict this: using the full length sequence of *A. sideensis* for a determination request, including all available sequences in BOLD-database (including unpublished and unnamed sequences, currently about 5.8 million, accessed 15. ii. 2019), the closest match is the North American species *Agonopterix eupatoriiella* (Chambers, 1878) with a p-distance of 2.78 %, followed by 8 further specimens of *A. eupatoriiella*, the first match for another species is *A. invenustella* Hannemann, 1953 with a p-distance of 3.19 %. This request shows the closest 99 sequences, the last of the list being *A. kaekeritziana* (Linnaeus, 1767) with a p-distance of 3.82 %. In total, 19 species are listed, all are *Agonopterix* spp., which is not a surprise, but *A. montuosella* is not found among the 99 closest sequences. Sequences of *A. sideensis* and *A. montuosella* show a p-distance of 4.75 %.

From *A. montuosella*, 2 specimens have been sequenced using NGS-protocol (Prosser et al., 2015) with rather good results. Both sequences show a sequencing gap from position 326-441, the remaining 569 bases were successfully sequenced, with an identical result in both specimens. Using this sequence of *A. montuosella* for the same kind of determination request, the closest match is the second *A. montuosella* (of course), followed by the North American species *A. oregonensis* Clarke, 1941 with a p-distance of 2.51 %; the next 6 matches are of 6 different species of *Agonopterix*, the 99th match is *A. carduncelli* Corley, 2017 with a p-distance of 3.72 %. In total 21 species, all in *Agonopterix*, are found among the 99 closest sequences.

So far, the conclusion of sequence analysis of *A. sideensis* and *A. montuosella* is that both are well nested in *Agonopterix* but they are not closely related, and, among all species that could be used for comparison, there is none that can be clearly identified as the closest relative of *A. sideensis* or *A. montuosella*.

It appears likely that the projection of the lower edge of the valva has developed independently in both species. The most important consequence of this conclusion is that this feature has no systematic value, and therefore it would be inappropriate to create a separate subgenus for these two species.

***Exaeretia lvovskyi* sp. n.**

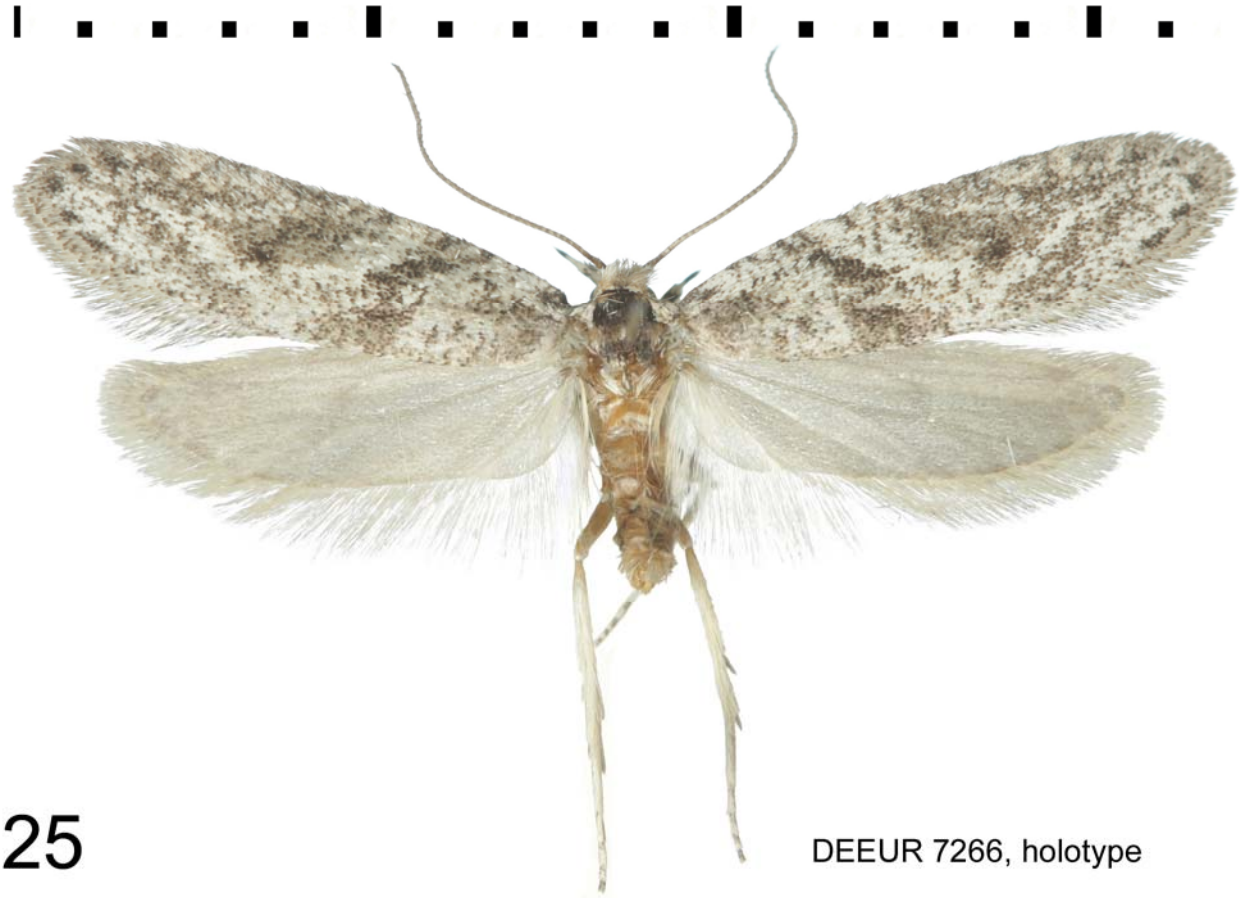
http://zoobank.org/NomenclaturalActs/F2AC14AD-B81F-4ED1-8806-A226F5952802

Description

Adult (figs 25 - 31): wingspan 15-18 mm. Scales of head light grey, interspersed with darker grey and brownish scales (fig. 29). Labial palpus: second segment about 1 mm long, narrow, whitish, with a variable proportion of dark grey scales, sometimes forming a subapical ring, third segment about 0.5 mm long, patterns similar (figs 28 - 29). Antenna mid-brown, narrow, diameter in the female about 2/3 of that in the male, this is the only externally visible difference between the sexes. Thorax with posterior crest, whitish irregularly interspersed with a variable proportion of mid to dark grey scales, with a tendency to be darker at front and rear edge and paler in the centre. Forewings narrow (length/width ratio about 3.3-3.7:1), strikingly pointed (angle between longitudinal axis and outer edge 30 - 40 degrees, fig. 27, red lines). Forewing with whitish and mid to dark grey elements, which are nowhere sharply or clearly demarcated, but nevertheless form a distinct pattern (pointed in fig. 27): basal part predominantly dark, followed by a light area running obliquely from about 1/8 of costa to about 1/4 of dorsum (area with blue line), a darker area beyond which includes the inner dark central spot (inner cyan arrow), which usually does not show clearly against its dark surrounding, a second light area beyond running obliquely from about 1/3

of costa to about 1/2 of dorsum (area with magenta line), a further darker area beyond which includes the outer dark central spot (outer cyan arrow), distally surrounded by an acute angled V-shaped whitish area with its 45 degree tip at about 3/4 (yellow marking), beyond the V-shaped pale band a narrow darker area, finally again followed by a small paler area (green marking). Dots between veins distinct, distinct dots also along costa, especially in basal half. Cilia with a pale base and pale tips, markedly darker inbetween, forming lines which are distinct especially in fresh specimens (fig. 27). Underside of forewing uniformly mid-grey, along outer edge some darker dots between veins (fig. 30). Hindwings uniformly greyish, only the edge a little darker, cilia with an indistinct dark subbasal line (figs 25, 27). Legs: covered with a mix of whitish and dark grey scales, with more dark scales in forelegs (fig. 31). Abdomen pale to mid-grey, without distinct patterns, somewhat darker laterally.

Variation: some variation was found in the specimens examined, especially in the labial palpus, where some specimens show a distinct blackish subapical ring (fig. 29), while in others it is diffuse or even absent (fig. 28). Also the extent of the white elements of the forewings varies, being wider and clearer in some individuals than in others. The dark central dots are nearly invisible in some individuals and distinct in others, but this may depend on age, because the central dots seem to be more resistant to being worn than other dark elements, resulting in the forewing dots contrasting more with the background in moderately worn specimens.



25 DEEUR 7266, holotype

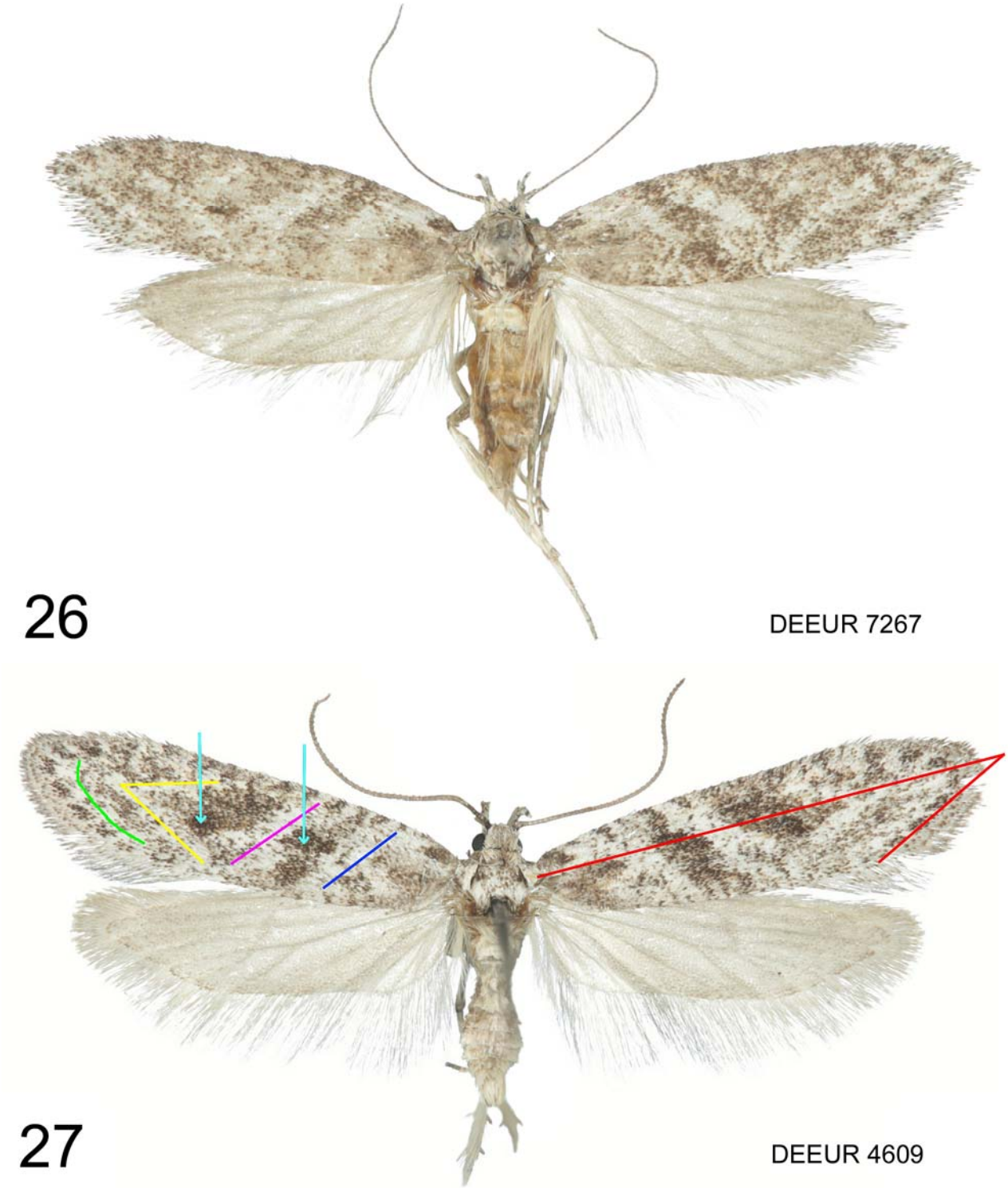


FIGURE 25: *E. lvovskyi*, holotype (♂), general view
FIGURE 26: *E. lvovskyi*, ♀ paratype , general view
FIGURE 27: *E. lvovskyi*, ♂ paratype, general view, for markings see description

FIGURE 28-29: *E. lvovskyi*, head and labial palpus

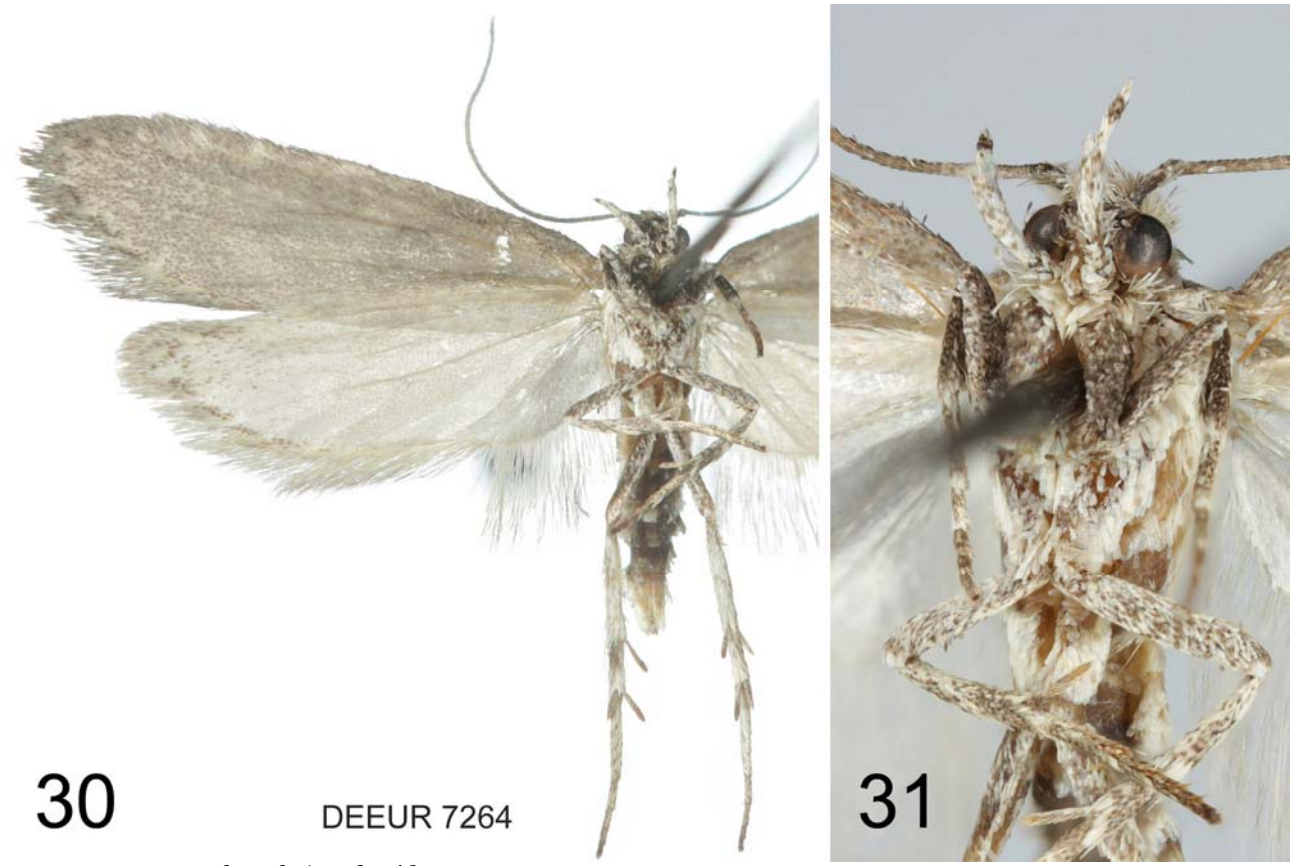


FIGURE 30-31: *E. lvovskyi*, underside

Male genitalia

Socii with straight edges in basal half (fig. 32a), with a rather sharp, right-angled bend at outer edge (32b), the further course of outer margin first straight (32c), but soon evenly rounded in distal half (32d), transverse diameter slightly (up to 1/5) exceeding tegumen width in standard preparation; gnathos nearly globose, about 1/10 longer than its diameter, medium sized (diameter about 2/5 of tegumen width in standard preparation), spinulae arranged in 6 rows; transtilla narrow, parallel-sided, transtilla lobes rather evenly rounded, medium sized, the gap between them

of about the same size; anellus reaching transtilla, with a V-shaped medial incision, without further structures (for details compare diagnosis), anellus lobes small (width not exceeding 1/6 of anellus diameter); valva broad (length/width ratio about 2:1) and blunt, cuiller with two branches, the one directed to the lower edge of valva small and acutely triangular, its tip extending clearly beyond lower edge of valva and ending at about 2/3 of it, edge of valva with bend of about 20 - 30 degrees inwards here (fig. 33, blue lines, angle marked with x); the branch directed to costa of valva similar or more broadly triangular, its tip about 1/4 of valva width from costa and at about 2/5 to 1/2 of valva length. Phallus slightly bent (20 degrees) in lateral view at 1/3 from base (fig. 32e), in ventral view sclerotization restricted to left side in distal part (fig. 32f), length 4/5 of valva, width about 1/4 of its length at base and 1/6 of it in distal 2/3, here (if vesica is not everted) with numerous cornuti, minute in basal part, becoming gradually larger to reach a length of up to diameter of phallus in distal part (enlarged insert fig. 33a), arranged in 2 or 3 not clearly separable groups.

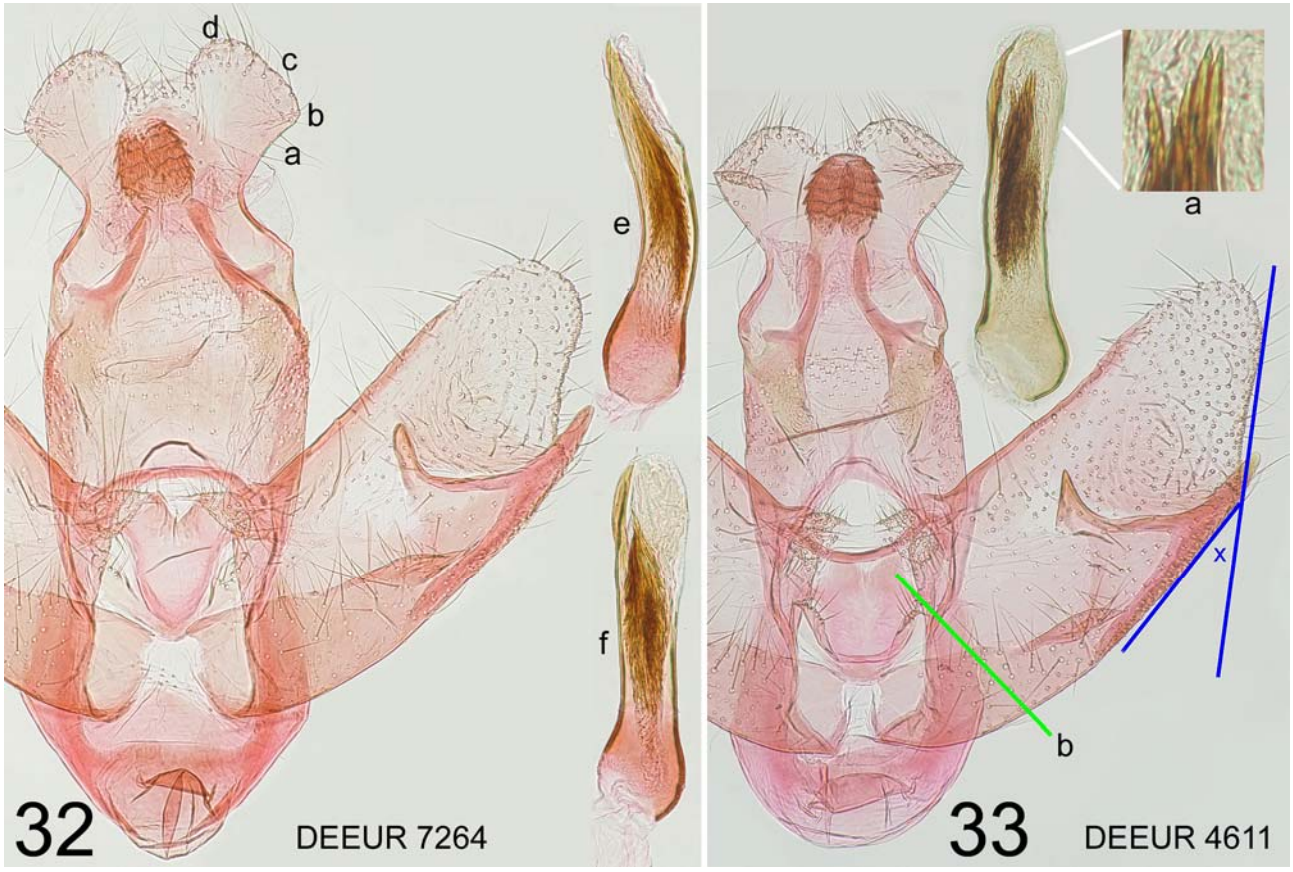


FIGURE 32-33: *E. lvovskyi*, male genitalia, for details see text

Female genitalia

Papillae anales oblique oval in lateral view (fig. 35), 1.1 mm long and 0.5 mm wide, apophyses posteriores 1.3 mm; sternite VIII 0.7 mm long, width of ventral projection in natural position 1.0 mm, maximum width 1.7 mm in standard preparation, apophyses anteriores 0.8 mm; proximal edge of sternite VIII slightly concave in centre with shallow bulges on either side 0.75 mm apart; ostium round, 0.1 mm from proximal edge, 0.2 mm in diameter, microtrichia absent in ostium and on sternite VIII; ductus bursae 2.0 mm long, widening continuously to 0.5 mm, origin of ductus spermathecae 0.15 mm from ostium, ductus spermathecae with about 4 turns; bursa copulatrix oval, 3.0 mm long and 2.0 mm wide in standard preparation, signum slightly distal from centre, oval, 0.7 mm long and 0.5 mm wide, the longitudinal axis without teeth, on either side of this area about 30 small triangular teeth pointing laterally.

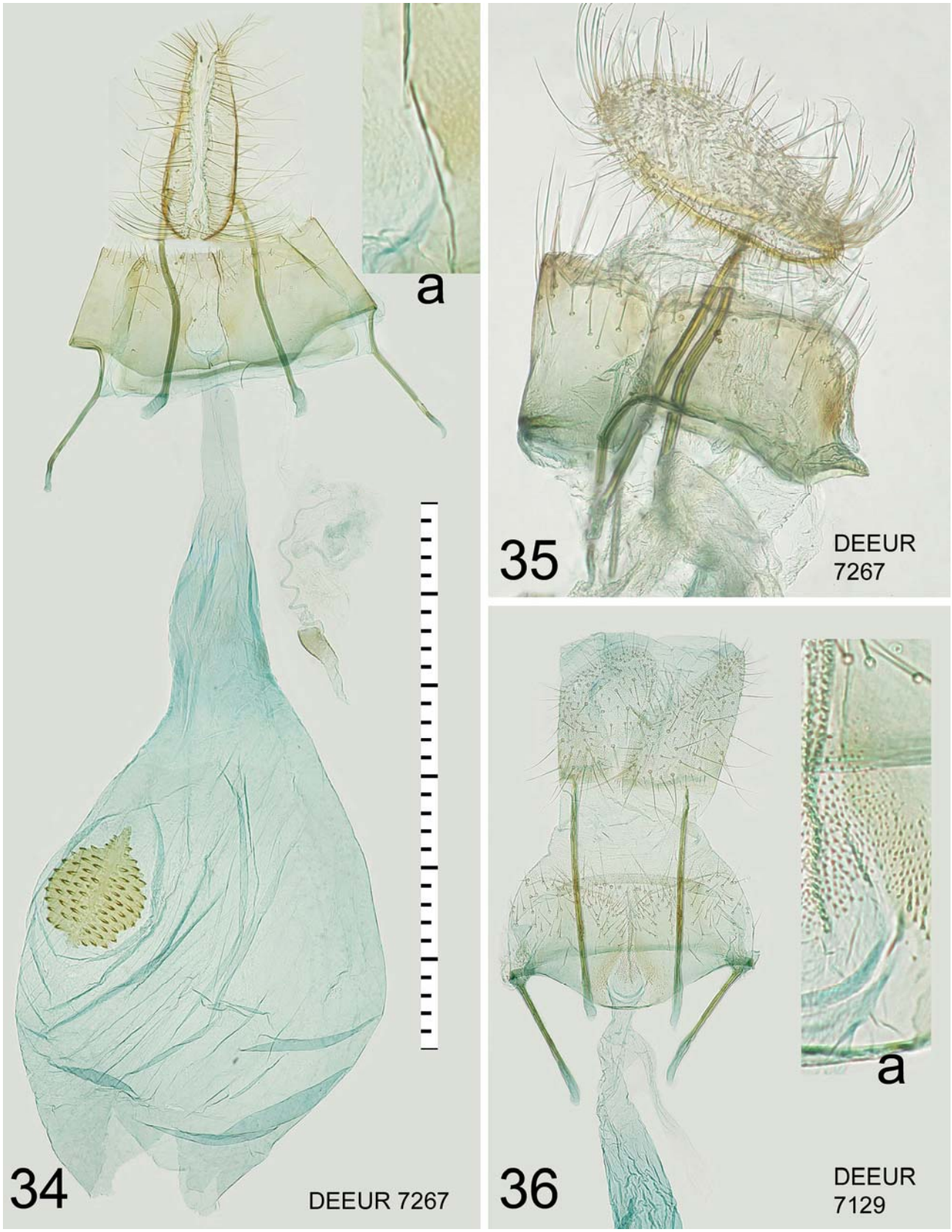


FIGURE 34: *E. lvovskyi*, female genitalia in standard preparation; insert 34a: area around ostium enlarged to show absence of microtrichia; scale bar: 1 line = 0.1 mm in the slide (only correct for fig. 34!).
FIGURE 35: *E. lvovskyi*, female genitalia, free floating, lateral view
FIGURE 36: *E. lepidella*, female genitalia in standard preparation; insert 36a: area around ostium enlarged to show field of microtrichia (Russia, Saratovsk district, leg. Anikin 3.vi.1992, coll. ZIN, dissection and storing genitalia in glycerol Alexander Lvovsky, staining, embedding & photo PB.)

Diagnosis

Examination of the genitalia of both sexes shows that they are very similar to those of several species of *Exaeretia*, which are characterized in the males by an undivided, globose gnathos with spinulae arranged in about 6 rows (figs 47-50, as examples from other group see figs 51-52); in females (as far as known) in the ostium being nearly circular, located near proximal edge of sternite VIII, ductus bursae rather short and bursa copulatrix large, signum without distally elongated sclerotization (figs 34-36, 53-55). These species are (not necessarily complete): *E. lepidella, E. nebulosella, E. buvati*, *E. mongolicella*, *E. amurella* and *E. praeustella* (REBEL, 1917), here treated as an informal "*Exaeretia lepidella* - species group".

Externally, *E. lvovskyi*, at least when fresh, is so distinct that it cannot be confused with any of these species; compare description and figs 37-42.

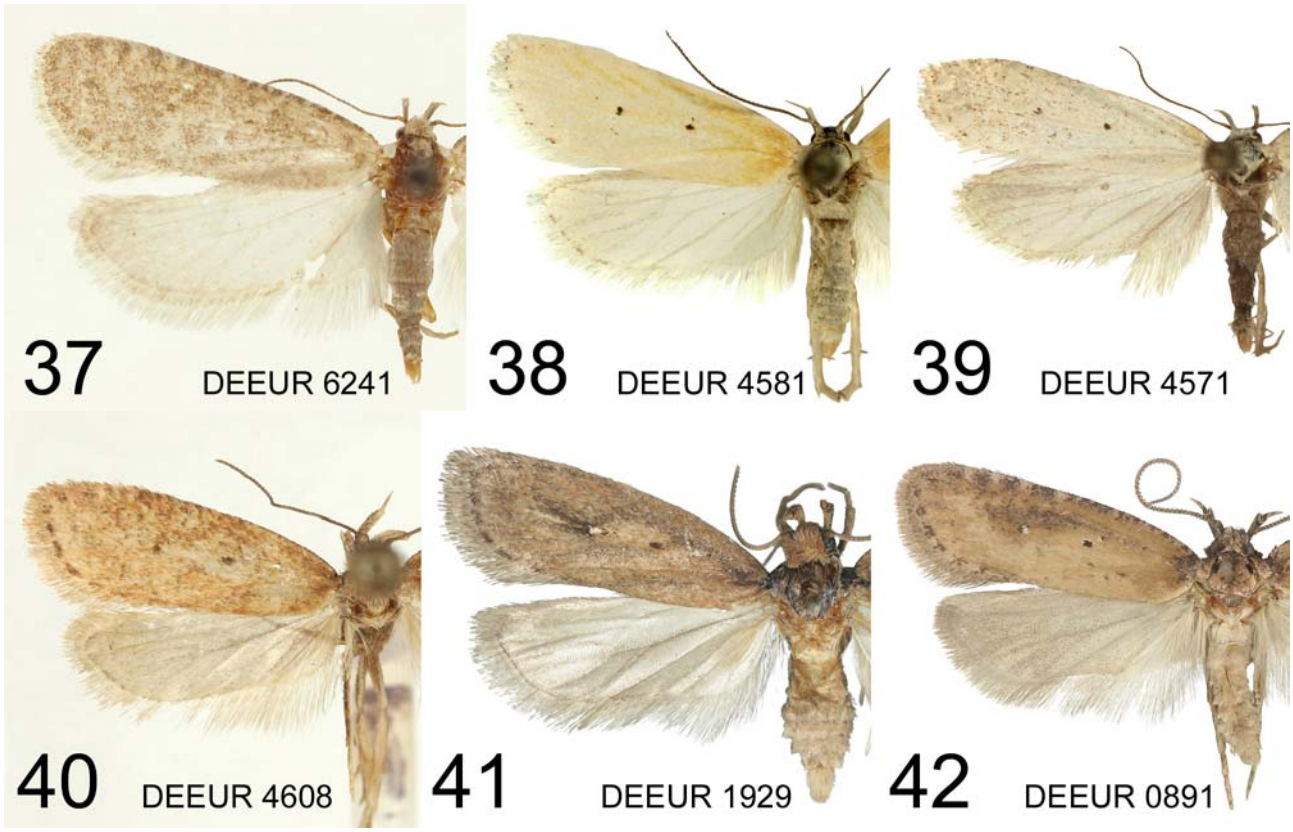


FIGURE 37: *E. nebulosella*, Kazakhstan, Uralsk, 10.v.1907, leg. Bartel, paralectotype, coll. MGAB
FIGURE 38: *E. lepidella*, Russia, Cheliabinsk district near Amurskii village, 15.vi.1996, leg. K. Nupponen et al., coll. RCKN
FIGURE 39: *E. buvati*, France, Pyrenees Orientales, Col de Puymorens, 1950 m, 15.vi.2003, leg. & coll. RCJJ
FIGURE 40: *E. amurella*, Russia, Orenburg district 12 km S Kuvandyk, 14.vi.1998, leg. K. & T. Nupponen, coll. RCKN
FIGURE 41: *E. mongolicella,* Russia, Vladivostok, vii.1994, leg. Kuznetzov
FIGURE 42: *E. praeustella,* Sweden, Oeland, Vickleby, ex larva, 15.vii.1959, leg. I. Svensson, coll. ZSM

In contrast to its external distinctness, it is difficult to find constant differences in the genitalia for a certain determination of *E. lvovskyi.*

In the males, the best distinguishing features are found in the shape of the lower edge of the valva and in the gnathos: in *E. lvovskyi,* the lower edge of the valva has a bend of about 20 - 30 degrees inwards besides the lower branch of cuiller, which allows the tip of the cuiller to clearly protrude beyond the edge of the valva (fig. 31, blue markings), while in the other compared species the lower edge of valva is nearly straight or evenly curved (without a distinct bend) and the tip of the cuiller not or only indistinctly protruding beyond the edge of the valva. Gnathos is slightly elongated (length/width ratio about 1.1-1.2:1), best seen in lateral view in free floating and therefore uncompressed genitalia (fig. 47), while it is globose or a little shorter than wide in the other mentioned species (figs 48-50). Also the anellus shows some helpful features, but for this it is necessary to take a more detailed look at the other species: in *E. praeustella* the distal excavation shows an irregular extension until its centre, so it appears the anellus has something like a hollow

there (fig. 43a), in *E. mongolicella* (and the genitalically inseparable species *E. amurella*) it has a deep V- or U- shaped excavation distally (fig. 44a), triangular tips laterally (44b) and no (or sometimes indistinct) pair of folds or humps on its surface (44c) In *E. lvovskyi* it is similar, but distal excavation is not as deep (figs 32-33) and folds or humps on its surface are absent (fig. 33b), in *E. lepidella* and *E. nebulosella* (which are not distinguishable genitalically) and *E. buvati* the distal excavation is shallow (fig. 46a) and folds or humps on its surface are distinct (fig. 45a)
In females, the best distinguishing feature is the absence of any spinulae (microtrichia) in and around the ostium (fig. 34a), while such microtrichia are found here in all the other mentioned "*Exaeretia lepidella* - group"species (figs 36a, 53a, 54a, but note, females of *E. nebulosella* and *E. amurella* are unknown).

Remarks on intraspecific variability and the determination problems caused by it: intraspecific variability of the genitalia is often underestimated, because in the relevant literature, usually only one example per species is figured. Therefore, two examples of the male genitalia of *E. lepidella* and also two of female genitalia of *E. praeustella* are shown to demonstrate the variability. In *E. lepidella* differences in the shape of the lower branch of the cuiller and the size of the anellus lobes (figs 45 versus 46) are larger than the average interspecific difference in this species-group. In *E. praeustella* the size and shape of signum in particular show a striking difference: while it is exceptionally small in fig. 54, it is of normal size but with another unusual individual feature in fig. 55 in having small, isolated sclerites extending far into the ductus bursae. In addition, one must still expect preparation artefacts. With this in mind, it is highly recommended not to make a determination on a single feature in the "*Exaeretia lepidella* - species group".

Material

Holotype: ♂, Russia, Altai Republic, Kosh-Agach Distr., Tašanta env. (10 km SW), Ulandryk valley, rocks, 49°40´33´´N; 89°04´09´´E, 30.vi.2015, 2200 m, leg. J. Šumpich, coll. NMPC, gen. prep. DEEUR 7266 P. Buchner; will be deposited in NMPC

Paratypes: 1 ♂, Russia, South Ural, Bashkiria Sakmara river valley, Jantyshevo village, 20.vi.1996, leg. K. Nupponen et al., gen. prep. J. Junnilainen 97031301, DEEUR 4473, coll. RCJJ

11 ♂, Russia, Altai Mountains, Kuraiskaja steppe, 50°14-16´N; 87°50-55´E, 1500–1700 m, 25.vi.2000, leg. T.& K. Nupponen, coll. RCKN, gen. prep. 1/26.ii.2001, 1/19.iii.2001 K. Nupponen, DNA barcode id. TLMF Lep 19226, DEEUR 4609 & DNA barcode id. TLMF Lep 19234, DEEUR 4500

6 ♂, Russia, Altai Mountains, Kuraiskaja steppe, 50°14-16´N; 87°50-55´E, 1500–1700 m, 27.vi.2000, leg. T.& K. Nupponen, coll. RCKN, DNA barcode id. TLMF Lep 19212, DEEUR 4657

1 ♂, Russia, Altai Mountains, Kuraiskaja steppe, 50°14-16´N; 87°50-55´E, 1500–1700 m, 5.vii.2001, leg. K. Nupponen, coll. RCKN

1 ♂, Russia, Buryatia, Hamar Daban mountains, Murtoy River valley, Gusinoe Ozero village 6 km NW, 51°11-13´N; 106°10-12´E, 700 m, 19.vi.2002, leg. K. Nupponen, coll. RCKN, gen. prep. DEEUR 4611 P. Buchner

22 ♂, 1 ♀, Russia, Altai Republic, Aktash vill., 50°19´12´´N; 87°36´00´´E, grassy steppe, rocks, 21.vi.2015, 1400 m, leg. J. Šumpich, coll. NMPC, gen. prep. ♀ DEEUR 7267 P. Buchner

1 ♂, Russia, Altai Republic, Kosh-Agach Distr., Chagan-Uzun env., Krasnaya Gorka Hill, 50°05´00´´N; 88°25´15´´E, rocky steppe, 1870 m, 29.vi.2015, leg. J. Šumpich, coll. NMPC

21 ♂♂, Russia, Altai Republic, Kosh-Agach Distr., Tašanta env. (10 km SW), Ulandryk valley, rocks, 49°40´33´´N; 89°04´09´´E, 30.vi.2015, 2200 m, leg. J. Šumpich, coll. NMPC; DEEUR 7265 & gen. prep. DEEUR 7264 P. Buchner

5 ♂, Russia, Altai Republic, Kosh-Agach Distr., Tašanta env. (8 km N), below „11. station", 49°44´11´´N; 89°20´02´´E, rocky steppe, meadows, 1.vii.2015, 2280 m, leg. J. Šumpich, coll. NMPC

2 ♂, 1 ♀, Russia, Altai Republic, Kurai Mts. Range, valley of Tabozhok river, 10 km NE Kosh-Agach village, 2100 m, E 88°44´ N 50°05´, 1.-3.viii.2016, leg. P. Huemer & B. Wiesmayr, 1 ♂ DNA barcode id. TLMF Lep 20432, coll. TLMF

Paratypes from the collection of NMPC are intended for distribution to the collections of MFN, NHMUK, ZIN, ZMUC and ZSM.

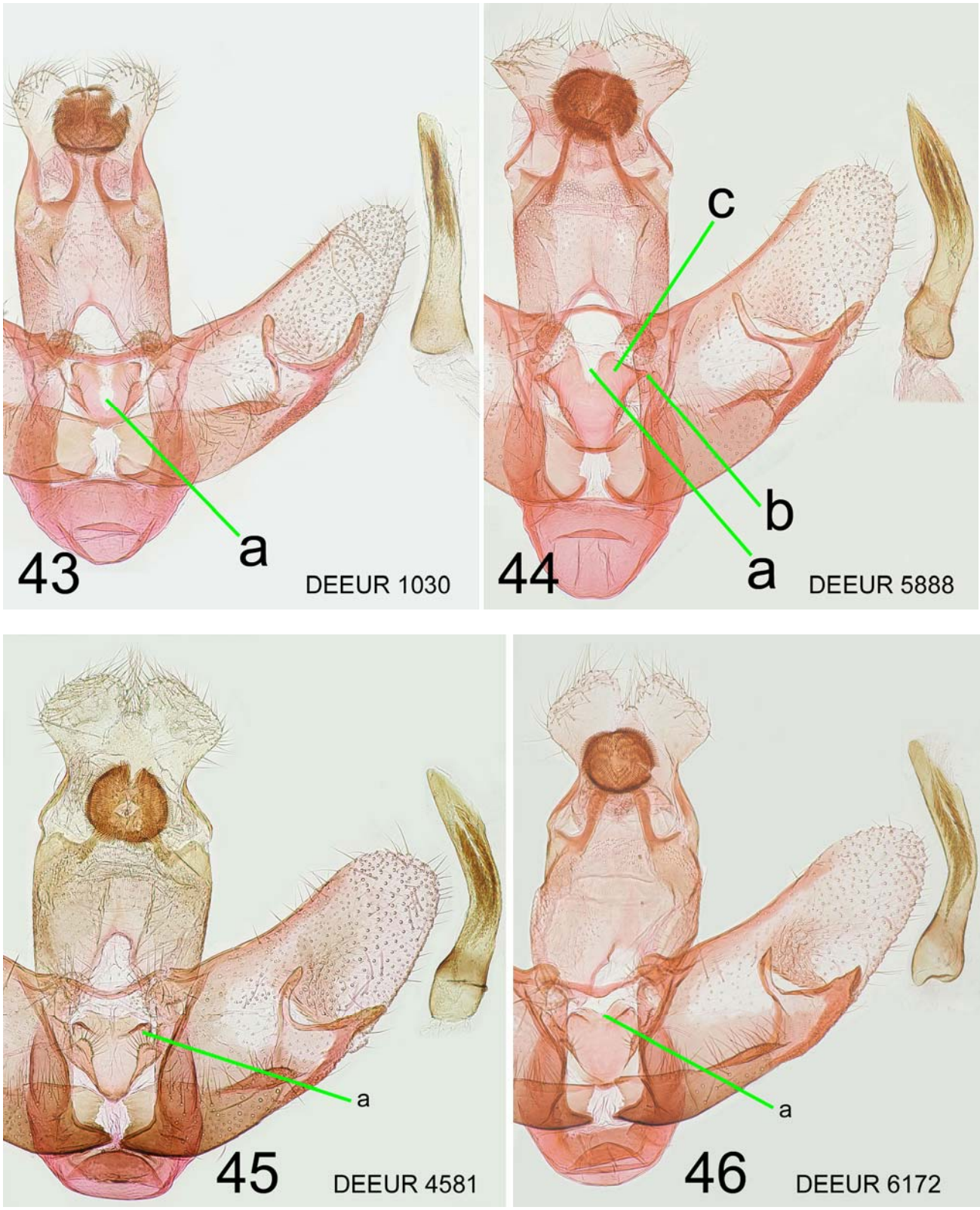


FIGURE 43: *E. praeustella*, Russia, Orenburg district, Kuvandyk, 27.viii.2011, leg. & coll. L. Srnka
FIGURE 44: *E. mongolicella*: Mongolia, Archangaj Aimak, Changaj Mountains, 8 km W Somon Urdtamit, 1620 m, 21.vii.1966, leg. Z. Kaszab, coll. HNHM
FIGURE 45: *E. lepidella*, Russia, Cheliabinsk district near Amurskii village, 15.vi.1966, leg. K. Nupponen et al., coll. RCKN
FIGURE 46: *E. lepidella*, Russia, Altai mountains, Aktash, 2260 m, 23.vi.2015, leg. J. Šumpich, coll. NMPC

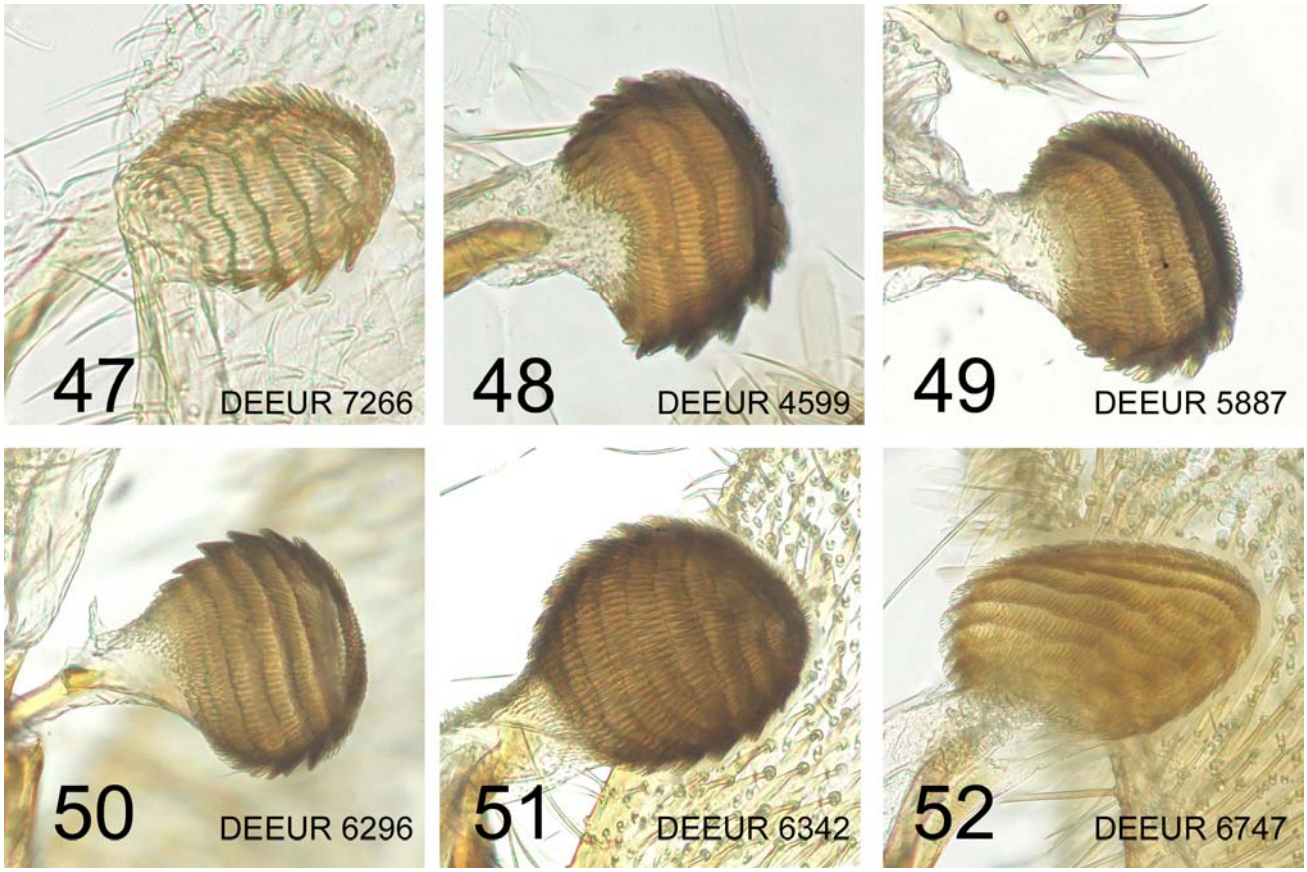


FIGURE 47: *E. lvovskyi*, holotype
FIGURE 48: *E. lepidella*, Russia, Cheliabinsk district, Moskovo, 26.v.1998, leg. K.& T. Nupponen, coll. RCKN
FIGURE 49: *E. mongolicella*: Mongolia, Bulgan aimak, 7 km W Somon Chanzargalant, 1350 m, 17.viii.1968, leg. Z. Kaszab, coll. HNHM
FIGURE 50: *E. praeustella*, Russia, Uralsk, 26.viii.1908, leg. Bartel, coll. MGAB
FIGURE 51: *E. thurneri*, Romania, Dobrogea, Hagieni Erdö, 19.ix.1980, coll. MGAB
FIGURE 52: *E. ledereri*, Croatia, Krk, 16.v.1996, leg. H. Haberler, coll. TLMF

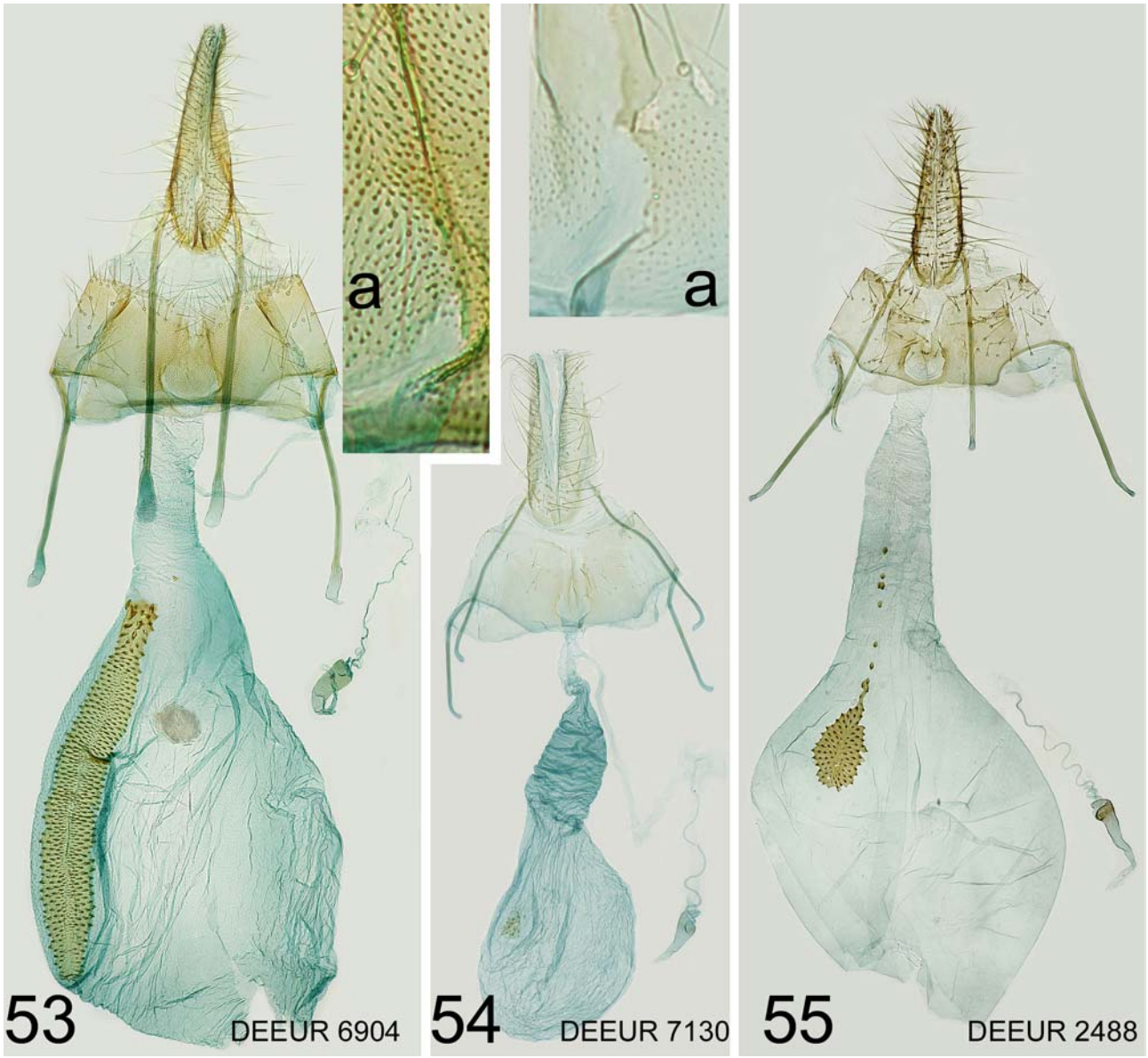


FIGURE 53: *E. mongolicella*, Mongolia, Central Aimak, 45 km E Somon Bajandeleger, 1340 m, 24.viii.1965, leg. Z. Kaszab, coll. MNHN, specimen EL62902, slide MNHN-EL41
FIGURE 54: *E. praeustella*, Estonia, 10.vii.1980, leg. A. Moravitsch, coll. ZIN
FIGURE 55: *E. praeustella,* Sweden, Oeland, Vickleby, ex larva *Artemisia campestris*, 14.vii.-1.viii.1995, leg. &. cult. H. Hendriksen, coll. ZMUC

Genetic data

Barcodes under

TLMF Lep 19212 (658 bp., ♂, Russia, Altai Mountains, Kuraiskaja steppe, 50°14-16´N; 87°50-55´E, 1500–1700 m, 27.vi.2000, leg. T. & K. Nupponen, coll. RCKN, DEEUR 4657)

TLMF Lep 19234 (658 bp., ♂, Russia, Altai Mountains, Kuraiskaja steppe, 50°14-16´N; 87°50-55´E, 1500–1700 m, 25.vi.2000, leg. T. & K. Nupponen, coll. RCKN, DEEUR 4500)

TLMF Lep 19260 (658 bp., ♂, Russia, Buryatia, Hamar Daban mMountains, Murtoy River valley, Gusinoe Ozero village 6 km NW, 51°11-13´N; 106°10-12´E, 700 m, 19.vi.2002, leg. K. Nupponen, coll. RCKN, gen. prep. DEEUR 4611 P. Buchner)

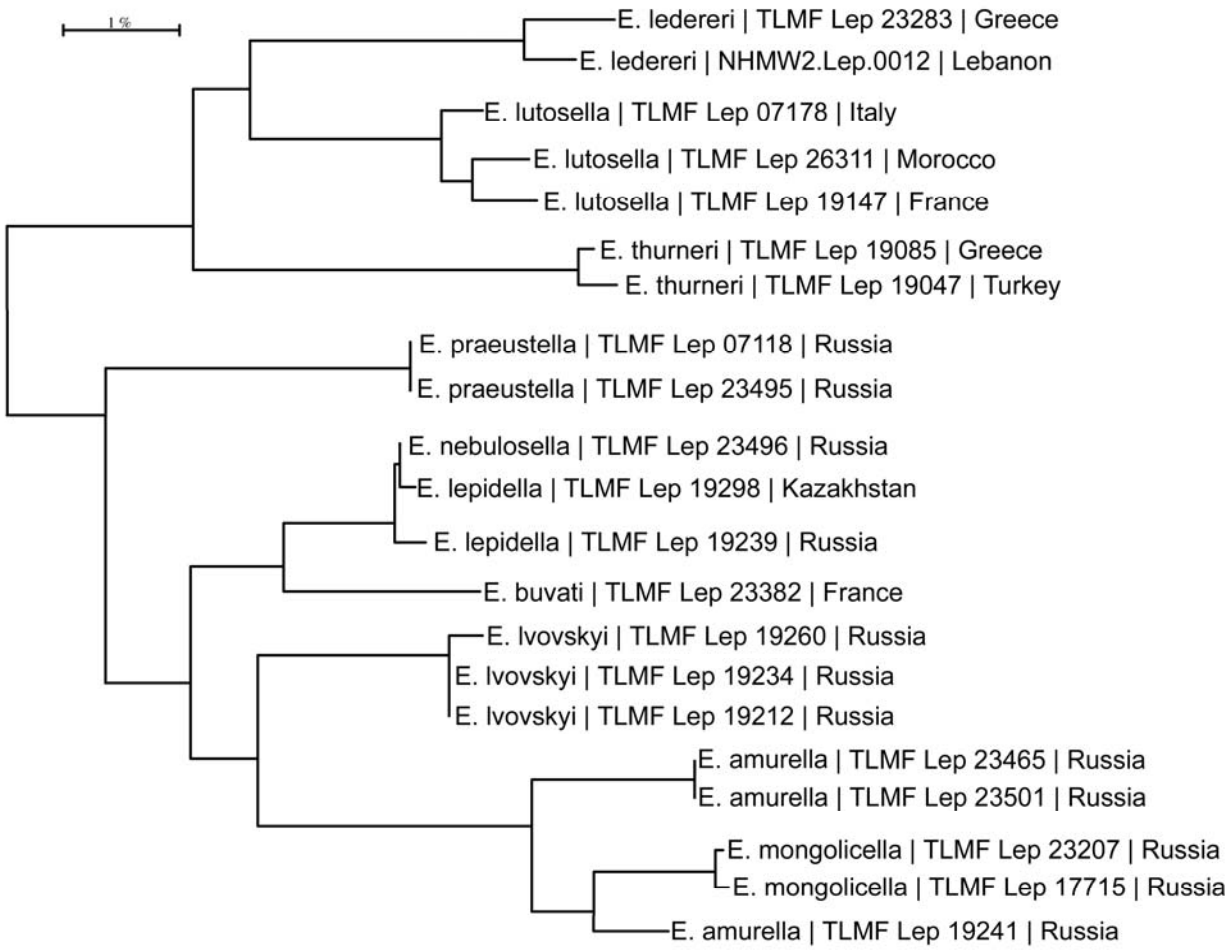


FIGURE 56: neighbour-joining tree of *Exaeretia lvovskyi* and the species of the "*E. lepidella* - group", also including further species (*E. lutosella*, *E. ledereri* & *E. thurneri*) as an outgroup

The sequences can be found in the dataset DS-DEEUR355, which is accessible via this doi: dx.doi.org/10.5883/DS-DEEUR355, for details see the table in Appendix

Related species

The assessment based on the comparison of the genitalia of both sexes is confirmed by the molecular data: *E. lvovskyi* is part of a species-group with *E. lepidella, nebulosella, buvati, mongolicella, amurella* and *praeustella* ("*E. lepidella*-group"). Neighbour-joining analysis shows *Exaeretia lepidella* as the nearest neighbour with 4.06% p-distance, but the other species of this group have nearly the same distance, and the comparison of the genitalia does not allow a decision as to which of the species is actually the nearest relative.

Distribution

So far known only from Russia: South Ural, Altai Mountains, Buryatia.

Biology

Hostplant unknown. Fresh moths have been collected at the end of June, predominantly at high altidudes, this indicates that the species hibernates as a (more or less full grown) larva or even as a pupa. Hibernation as adults is unlikely, because this mean a complete development from egg to adult moth in the short time from the spring to the end of June. In *E. praeustella*, the only species in this group which is known to hibernate as adults (Lvovsky, 2013), fresh specimens predominantly have not been found earlier than the end of July, with one lowland record (Estonia) from 10.vii.

FIGURE 57: collecting site of *Exaeretia lvovskyi* - holotype in the Altai Mountains, photo: J. Šumpich

Derivation of name

The name honours the Russian Depressariidae specialist Alexander Lvovsky, who has described more species from this family from Russia in the last few decades than any other lepidopterist, and who has always been ready to assist the authors on technical questions.

Acknowledgements

The authors are most grateful to Dr Laszlo Ronkay (HNHM, Budapest), Dr Wolfram Mey (MFN, Berlin), Dr Paolo Glerean (MFSN, Udine), Prof. Joël Minet (MNHN, Paris), Dr Martin Lödl and Dr Sabine Gaal-Haszler (NHMV, Vienna), Ing. Jan Šumpich (NMPC), Dr Robert Trusch (SMNK, Karlsruhe), Dr Peter Huemer (TLMF, Innsbruck), Dr Sergey Sinev and Dr Alexander Lvovsky (ZIN, St. Petersburg), Dr Andreas Segerer (ZMS, Munich), Mr Ole Karsholt (ZMUC, Copenhagen) and Toni Mayr (Austria), Cs. Szabóky (Hungary) and Lubomir Srnka (Slovakia) for the loan of specimens; Ing. Jan Šumpich for additional comments; Dr Vladimir Olschwang (Ekaterinburg, Russia) for organizing the expeditions to Altai (2000 & 2001) and Buryatia (2002); the Canadian Centre for DNA Barcoding (Guelph, Canada), whose sequencing work was enabled by funding from the Government of Canada to Genome Canada through the Ontario Genomics Institute; Martin Corley for linguistic corrections, Robert Heckford for a final review and and Prof Dr Ahmet Ö. Koçak for the offer to publish in this paper.

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Ratnasingham, S. & Hebert, P.D.N. (2007) BOLD The Barcode *of* Life Data System (http://www.barcodinglife.org/) — *Molecular Ecology Notes* 7: 355-364.

Robinson, G. S. (1976): The preparation of slides of lepidoptera genitalia with special reference to the microlepidoptera. *Entomologist´s Gazette* 27: 127–132.

APPENDIX. Table with details to BIN, Sample ID, Process ID and GenBank Accession for 40 sequences, used for the neighbour-joining trees in this paper.

Species	Barcode Index Number (BIN)	Sample ID	Process ID	GenBank Accession
Agonopterix bipunctosa	BOLD:ABA0011	TLMF Lep 23187	DEEUR1349-17	MK585829
Agonopterix broennoeensis	BOLD:ACF4026	TLMF Lep 23477	DEEUR1639-18	
Agonopterix carduncelli	BOLD:ABZ7583	TLMF Lep 22013	DEEUR1219-17	MK585838
Agonopterix carduncelli	BOLD:ABZ7583	TLMF Lep 07017	DEEUR338-12	KY754265
Agonopterix caucasiella	BOLD:AAJ7538	TLMF Lep 17707	DEEUR512-15	MK585821
Agonopterix kaekeritziana	BOLD:AAF7198	TLMF Lep 23286	DEEUR1543-18	MK585836
Agonopterix kaekeritziana	BOLD:AAF7198	TLMF Lep 19265	DEEUR931-16	MK585845
Agonopterix kaekeritziana	BOLD:AAF7198	TLMF Lep 06262	DEEUR237-11	KP976158
Agonopterix kaekeritziana	BOLD:AAF7198	BC TLMF Lep 19286	DEEUR761-16	KY754262
Agonopterix montuosella		MFN-29197-B03	DEEUR1440-18	MK585826
Agonopterix montuosella		NHMW2.Lep. 0080	DEEUR1486-18	MK585842
Agonopterix pallorella	BOLD:ABU5790	TLMF Lep 06248	DEEUR223-11	MK585824
Agonopterix pallorella	BOLD:ABU5790	TLMF Lep 07014	DEEUR335-12	KY754263
Agonopterix sideensis	BOLD:ADC8999	TLMF Lep 19226	DEEUR898-16	MK585815
Agonopterix squamosa	BOLD:ACF7120	TLMF Lep 23309	DEEUR1566-18	MK585828
Agonopterix squamosa	BOLD:ACF7120	TLMF Lep 07136	DEEUR457-13	KP976133
Agonopterix straminella	BOLD:ACZ3539	TLMF Lep 19065	DEEUR635-16	MK585832
Agonopterix straminella	BOLD:ACX7863	TLMF Lep 17699	DEEUR504-15	KY754276
Agonopterix straminella	BOLD:ACX7863	TLMF Lep 17727	DEEUR532-15	KY754243
Exaeretia amurella	BOLD:ADL3394	TLMF Lep 19241	DEEUR909-16	MK585831
Exaeretia amurella	BOLD:ADL5281	TLMF Lep 23501	DEEUR1663-18	MK585833
Exaeretia amurella	BOLD:ADL5281	TLMF Lep 23465	DEEUR1627-18	MK585834
Exaeretia buvati	BOLD:ACW1404	TLMF Lep 23382	DEEUR1734-18	MK585839
Exaeretia ledereri	BOLD:ACW1733	DEEUR1057-17	NHMW2.Lep. 0012	MK585823
Exaeretia ledereri	BOLD:ACW1733	TLMF Lep 23283	DEEUR1540-18	MK585835
Exaeretia lepidella	BOLD:ACX7885	TLMF Lep 19239	DEEUR907-16	MK585837
Exaeretia lepidella	BOLD:ACX7885	BC TLMF Lep 19298	DEEUR773-16	MK585843
Exaeretia lutosella	BOLD:AAU4299	TLMF Lep 26311	DEEUR1841-18	MK585814
Exaeretia lutosella	BOLD:AAU4299	TLMF Lep 19147	DEEUR717-16	MK585817
Exaeretia lutosella	BOLD:AAU4299	TLMF Lep 07178	PHLAI974-14	MK585841
Exaeretia lvovskyi	BOLD:ADC5991	TLMF Lep 19212	DEEUR886-16	MK585819
Exaeretia lvovskyi	BOLD:ADC5991	TLMF Lep 19234	DEEUR863-16	MK585820
Exaeretia lvovskyi	BOLD:ADC5991	TLMF Lep 19260	DEEUR928-16	MK585840
Exaeretia mongolicella	BOLD:ACX8837	TLMF Lep 17715	DEEUR520-15	MK585825
Exaeretia mongolicella	BOLD:ACX8837	TLMF Lep 23207	DEEUR1369-17	MK585827
Exaeretia nebulosella	BOLD:ACX7885	TLMF Lep 23496	DEEUR1658-18	MK585830
Exaeretia praeustella	BOLD:ACF8204	TLMF Lep 07118	DEEUR439-13	MK585816
Exaeretia praeustella	BOLD:ACF8204	TLMF Lep 23495	DEEUR1657-18	MK585844
Exaeretia thurneri	BOLD:ACZ3391	TLMF Lep 19047	DEEUR617-16	MK585818
Exaeretia thurneri	BOLD:ACZ3391	TLMF Lep 19085	DEEUR655-16	MK585822

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